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USE OF KAOLIN FROM THE ZHURAVLINYI LOG DEPOSIT IN THE PRODUCTION OF HIGH-VOLTAGE INSULATORS

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The use of concentrated kaolin from the Zhuravlinyi Log deposit instead of Prosyansovskii kaolin in the production of high-voltage insulators is investigated. The resulting products have better mechanical and electrophysical parameters.

Numerous raw material deposits suitable for production of insulation porcelain are now outside the territory of Russia. Consequently, search and prospecting for new deposits of high-quality kaolins is of great significance.

The most promising and suitable for Russian raw material resources is kaolin from the Zhuravlinyi Log deposit (Southern Urals) which has been widely tested in the production of household porcelain [1, 2].

The kaolin from this deposit is a mixture of kaolinite and quartz which was formed as a consequence of microclinal granite weathering and has a bed thickness between 3.5 and 30.5 m. The color of the bed varies from white to yellow. The quartz content in the kaolin ranges within the limits of 35–70%. Concentration of the kaolin can be relatively easily accomplished, since it contains rather large quartz grains.

The kaolin consists of kaolinite and substantial quantity of halloysite, and also contains a slight amount of impurities, i.e., up to 0.5% sericite (which is a variety of muscovite). The content of coloring oxides does not exceed 1.5%. Kaolinite is represented by large-laminated aggregates (1–5 μm) and individual microcrystals (0.5–1.0 μm).

The ceramic industry uses concentrated kaolin whose chemical compositions is shown in Table 1.

The granulometric composition of the kaolin is as follows: 0.25–0.05 mm fraction — 0.0–3.8%; 0.05–0.01 mm — 17.5–18.0%; 0.01–0.005 mm — 12.4–15%; 0.005–0.001 mm — 28.8–30.3%, below 0.001 mm — 33.4–58.0%. The mineral composition is (%): 77–95 kaolinite, 1.0–1.5 quartz; traces: 7.0 mica; traces: 0.5 feldspar; and traces: 0.2 carbonates.

In the course of the present investigation, Prosyansovskii kaolin in the production of insulation porcelain at the

Mosizolyator JSC was replaced by kaolin from the Zhuravlinyi Log deposit.

The chemical composition of the mixture was calculated anew, taking into account the chemical composition of the

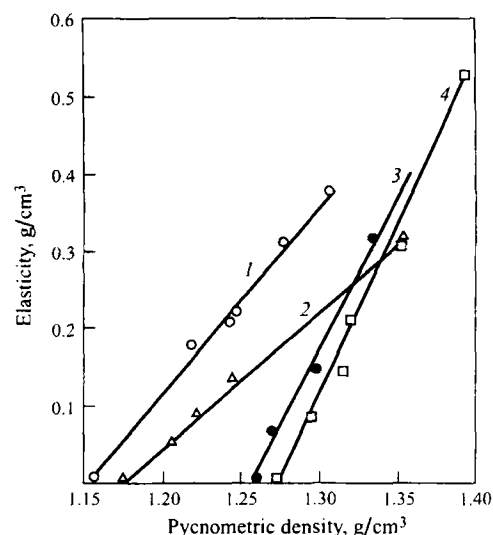


Fig. 1. Structure formation threshold of Zhuravlinyi Log kaolin suspension (1), Prosyansovskii kaolin suspension (2), industrial mixture (3), and experimental mixture (4).

TABLE 1

Kaolin	Mass content, %							calcination loss
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	alkali	
Initial	68.98	20.92	0.48	0.55	0.80	0.58	0.85	7.34
Washed	47.90	35.38	0.40	0.50	0.70	0.50	0.80	13.70

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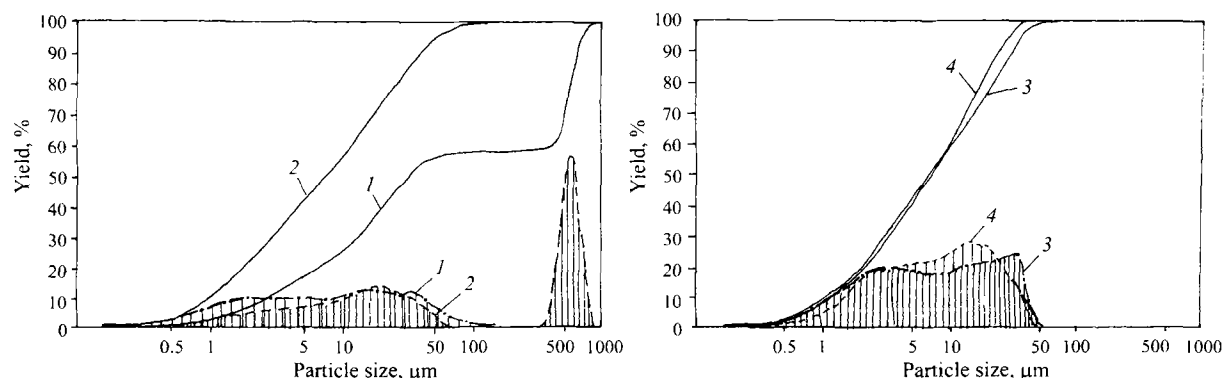


Fig. 2. Curves of particle distribution by size: 1) Zhuravlinyi Log kaolin; 2) Prosyankovskii kaolin; 3) experimental mixture; 4) industrial mixture.

experimental kaolin. In order to obtain comparable data, the rest of the components were taken without variations: quartz sand from the Tashlinskii deposit, clay from the Druzhkovskii deposit, and pegmatite of grade KPSHm (quartz-feldspar material) from the Chupinskii deposit whose grain size was 0.2–0.9 mm. The batch compositions of the industrial and the experimental mixtures are shown in Table 2.

The components were crushed together by wet grinding for 15 h to a residue of 2.37% on a sieve with 0.04 mm cell size. The specific weight of the slip was 1.32 g/cm³ and the moisture was 61.2%.

In order to obtain a plastic mixture with 22–23% moisture, the slip was dehydrated in a gypsum mold on a nylon filtering fabric, and then experimental samples were molded on a vacuum press. Samples of the mixture used in industrial production were molded in the same way.

The chemical compositions of the industrial and the experimental mixtures are presented in Table 3.

The determination of the structure-forming threshold indicated that the elasticity of the suspension based on Zhuravlinyi Log kaolin is higher than that of the suspension based on Prosyankovskii kaolin. (Fig. 1). It was found that the values of the structure formation thresholds of the kaolin suspensions and the slips based on these suspensions differ insignificantly. The structure formation parameters (g/cm³) were as follows: Prosyankovskii kaolin — 1.15, Zhuravlinyi Log kaolin — 1.17; industrial slip — 1.26; experimental slip — 1.27.

Study of the dispersion using an Analyzette-22 laser sedimentograph (Germany) revealed that Prosyankovskii kaolin is more finely dispersed than Zhuravlinyi Log kaolin (Fig. 2). The obtained data indicate that Zhuravlinyi Log kaolin is more coarsely dispersed due to its content of free quartz, which requires either joint milling with grog materials, or preliminary concentration.

The granulometric compositions of the slips made of the experimental and industrial mixtures were similar (Fig. 2). The parameters of methylene blue adsorption were similar to

those of dispersion. The methylene blue adsorption (mg/g) was: for Prosyankovskii kaolin — 15.0; for Zhuravlinyi Log kaolin — 10.5; for the industrial mixture — 16.5; and for the experimental mixture — 17.0.

The plasticity of the kaolins and the mixtures was close. Thus, the plasticity number for Prosyankovskii kaolin was 17.2; for Zhuravlinyi Log kaolin — 16.5; for the industrial mixture — 11.0, for the experimental mixture — 10.6.

Since a ceramic mixture in production should retain its continuity and homogeneity, determination of the optimum molding conditions is an important problem. In order to determine the molding moisture, the dependence of the ultimate plastic strength on moisture was found using the Rebinder cone (Fig. 3). After mathematical processing of the obtained results it was established that the optimum molding

TABLE 2

Component	Mass content, %, in the mixture	
	industrial	experimental
Chupinskii pegmatite	20.40	26.49
Tashlinskii sand	33.10	4.34
Druzhkovskii clay	19.00	19.17
Prosyankovskii kaolin	27.50	—
Zhuravlinyi Log kaolin	—	50.00

TABLE 3

Mixture	Mass content, %								
	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	K ₂ O	Na ₂ O	calcination loss
Industrial	67.07	20.10	0.50	0.40	0.35	0.44	2.00	0.86	5.70
Experimental	64.82	23.20	0.62	0.42	0.79	0.13	2.28	0.93	6.68

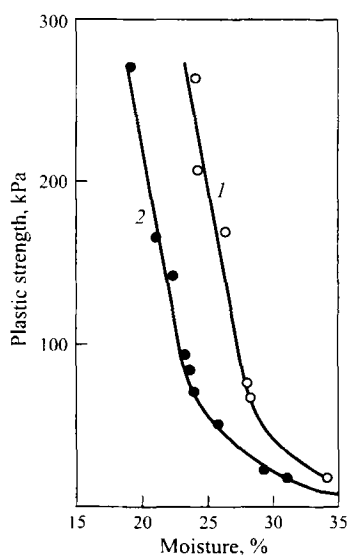


Fig. 3. Plastic strength versus the absolute moisture of the experimental (1) and industrial (2) mixtures.

TABLE 4

Mixture samples	Firing shrinkage, %	Apparent density, g/cm ³	TCLE, 10 ⁻⁶ °C ⁻¹ in 20–300°C interval
Industrial	8.6	2.30	6.34
Experimental	8.8	2.39	5.17

moisture (the absolute moisture) for the industrial mixture was 23.9%, and for the experimental mixture it was 17.4%.

The Tolstoi instrument was used to determine the plastic deformation of the mixtures with the optimum moisture, which made it possible to ascribe the considered plastic mixtures to types 1–2 and type 5 (according to Nechiporenko). This proves that the molding properties of the mixtures are satisfactory.

The strength of the samples in the air-dry state under three-point bending was 1.3 and 2.1 MPa using the Prosyanskiy kaolin and the Zhuravlini Log kaolin, respectively.

The samples made of the industrial and experimental mixtures had a strength of 4.6 and 5.1 MPa, respectively. As can be seen, the strength of the samples made of Zhuravlini Log kaolin and mixtures in the air-dry state based on this kaolin are higher than those of Prosyanskiy kaolin and mixtures based on it. The strength of the fired samples of the industrial and experimental mixtures was 86.7 and 103.3 MPa, respectively.

Some properties of the samples after firing are given in Table 4.

An important property of insulation porcelain is its electric strength. This parameter was 32.8 kW/mm for the experimental mixture samples and 28.6 kW/mm for the industrial mixture samples, and the tangent of the dielectric loss angle was $18 \cdot 10^{-2}$ and $20 \cdot 10^{-2}$, respectively, which satisfies the requirements of GOST 20419–83.

The results of the microstructural analysis revealed that the experimental mixture samples contain more mullite (29%) than the industrial mixture samples (22%). The microstructural analysis made it possible to infer that the industrial mixture contains a substantial amount of quartz, and the quartz grains are angular and strongly fused (the edge 1–3 μm thick), the average grain size being 5–15 μm. The pseudomorphoses are distinguished by clear contours and filled with mullite in the form of thin needles with particle size 1–2 μm.

The quartz grains in the experimental mixture sample have an angular shape but are less fused (edge 1–2 μm thick). The average grain size is 15–30 μm. The pseudomorphoses have clear contours and are filled with fine-grained mullite.

Thus, kaolin from the Zhuravlini Log deposit can be used instead of Prosyanskiy kaolin for manufacturing insulation porcelain products.

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